RELATIONSHIP BETWEEN ADHERENCE TO THE MEDITERRANEAN DIET AND HEALTH-RELATED QUALITY OF LIFE AND LIFE SATISFACTION AMONG OLDER ADULTS

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Abstract: *Objectives:* Evaluate the relationship between adherence to the Mediterranean diet and health-related quality of life and degree of life satisfaction among older adults. *Design and Setting:* Cross-sectional descriptive study. *Participants:* A total of 351 people older than 60 years participated in the study. *Measurements:* The Mediterranean Diet Score (MDS) was calculated to assess the degree of adherence to the MD. MD adherence was related to health-related quality of life using the Short Form Healthy Survey (SF-12) questionnaire, to life satisfaction using the Satisfaction with Life Scale (SWLS), and to sociodemographic, clinical and lifestyle variables. Multiple logistic regression models were used to analyse this relationship. *Results:* Mediterranean diet adherence was related to health- related quality of life. Participants with better adherence to the MD were more physically active ($p=0.01$) and had better health-related quality of life ($p<0.05$) and lower consumption of alcoholic beverages ($p=0.04$). The age-adjusted model showed a significant association between the MD and mental function for both sexes and with physical function only for men. The fully adjusted model showed a direct relationship between the MD and life satisfaction of women ($p>0.05$) but not for that of men ($p=0.31$). *Conclusions:* The adherence to the MD is directly associated with the self-perceived physical and mental function of both sexes and with the life satisfaction of women. Further studies in older adult populations should be performed to obtain conclusive results on the MD effect on health-related quality of life, including wellness indicators.

Key words: Mediterranean diet, older adults, adherence, health-related quality of life, life satisfaction.

Introduction

The Mediterranean Diet (MD) is considered a healthy eating pattern that combines tasty food that leads to health benefits (1, 2). The MD is typically rich in foods of plant origin (fruits, vegetables, cereals, nuts, seeds and legumes), with a significant intake of fish and olive oil (the main dietary fat added to the diet), moderate intake of eggs, poultry, dairy (mainly cheese and yoghurt) and alcohol (mainly in the form of wine during meals) and low intake of red meat and processed meats (3).

Specifically, good adherence to the MD has been associated with a reduced risk for cardiovascular disease, cancer and chronic-degenerative diseases and improved nutritional status and physical function (4-11). Numerous scientific studies have shown that these benefits are even more apparent among older adults, and the number of studies analysing this relationship has increased considerably in recent years (1, 6, 12-14). Internationally, different studies performed in older adults concluded that nutrients present in foods typical of the MD (vitamins E and B, folates, monounsaturated fatty acids, carotenes and antioxidants) effectively reduce cognitive impairment, improve nutritional status and blood pressure and decrease global mortality (6, 8, 9, 15-17). In Spain, different studies concluded that high adherence to the MD is associated with reduced mortality, a high level of self-perceived health (1) and improved health-related quality of life among older adults (12, 13, 14).

Quality of life as the basis of optimal ageing is closely related to well-being markers, with life satisfaction being one of the most important (15). Life satisfaction is determined as an overall self-assessment that compares an individual's life achievements with expectations (18). Thus, people assess their current state and their future expectations for themselves (18). In recent years, life satisfaction studies have focused on social services and health care, with little research on basic needs, including food. Although human nutrition is a key element of human health (16), no studies have been published that evaluate the relationship between life satisfaction and adherence to the MD in the older adult population. However, recent studies in other populations have found a positive relationship between life satisfaction and diet (17, 19-20). Specifically, at an international context, a study of obese subjects conclusively showed an improvement in life satisfaction after a 12-week period following a typical MD (17). In our context, studies have focused on adolescent populations, wherein subjects with greater adherence to the MD showed better lifestyles and greater satisfaction with their lives (19, 20).

The above highlights the importance of studying the relationship between health-related quality of life and life satisfaction with adherence to the MD among older adults

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because increase adherence to the MD could improves health, thereby improving the health-related quality of life and increasing life satisfaction.

Thus, our study aimed to evaluate the relationship between adherence to the MD and both health-related quality of life and degree of life satisfaction among older adults.

Methods

Study sample

A total of 351 people older than 60 years living in the Spanish Mediterranean area participated in this study. All subjects were volunteers and signed the informed consent to participate in the study. Participants were selected from an environment close to the interviewers, following a snowball strategy. Subjects who scored 3 or more errors on the Short Portable mental Status Questionnaire and those who were illiterate were excluded from the study.

The present study has been approved by the Ethics Committee of the University of Alicante (UA-2016-02-11). This study was conducted according to the criteria in the Declaration of Helsinki and the Good Clinical Practice Standards of the European Union. Anonymous codes were assigned to identify the study participants to ensure the strict confidentiality of the data. After data collection, a member of the research team entered the data into the study database. No personal data on the participants enabling their identification was included in the database at any time. All study participants read and signed the informed consent form to participate in the study.

Instruments

Dietary intake

Food consumption and nutrient intake were assessed using the short food frequency questionnaire (MEDIS-FFQ) validated for older adult populations living in Mediterranean areas (21). The questionnaire consisted of a list of foods, including alcoholic and non-alcoholic beverages, which are organised into eleven food groups: dairy, cereals and starchy foods, meats, fish, vegetables, fruits and nuts, snacks, sweets and salty snacks, drinks and fats. The questionnaire also included the weight of the reference portions. A photo album with the actual size of the portions was prepared, by the authors, for an easy to understand manner of determining the size of each food (figure 1).

Participants indicated their usual frequency of consumption by choosing one of six frequency categories: twice or more daily, once daily, three to six times a week, one to two times a week, one to three times a month and never or almost never. All consumption frequencies were re-categorised into a single frequency to assess the average daily intake of each food, and the nutrient intake was estimated using the table of food composition of the Institute of Nutrition and Food Technology of the University of Granada (22, 23).

Mediterranean Diet Score

The Mediterranean diet score (MDS) was calculated to assess the degree of adherence to the MD (24, 25). The MDS is based on the intake of vegetables, legumes, fruits and nuts, cereals, fish, meat and meat products, dairy products, olive oil and red wine. A value from 0 to 1 was assigned to each of the nine food groups, using the sex-specific median as the cut-off (24, 25). A value of 0 was assigned to those whose intake was below the median, and a value of 1 to those whose intake was above the median for beneficial components of the MD (vegetables, legumes, fruits and nuts, cereals and fish). The reverse assignment was performed for each food group considered harmful (meat products, meat and dairy products): A value of 1 was assigned to those whose consumption was below the median, and a value of 0 to those whose consumption was above the median. The reference values for alcohol consumption were adjusted by sex, as the original score indicates (27,28). In this case, the value of 1 was assigned to men whose consumption was ranged from 10 to 50 g per day and to women whose consumption ranged from 5 to 25 g per day. The monounsaturated fat/saturated fat (MUFA/SFA) ratio was used for fat intake. A value of 1 was assigned to subjects whose consumption was above the median, and a value of 0 was assigned to those whose consumption was below the median. The resulting MDS ranged from 0 (minimal adherence to the MD) to 9 (maximal adherence to the MD; 25).

Life satisfaction

The Spanish version (26) of the Satisfaction with Life Scale (SWLS) was used to evaluate the degree of life satisfaction (18). This scale consists of five items with multiple-choice answers, whose values ranged from 5 “strongly agree” to 1 “strongly disagree”. The final result from the scale was calculated by adding the scores for each item. Therefore, the scores ranged from five to 25. This instrument shows good psychometric properties with a 0.88 Cronbach’s alpha (26).

Health-related quality of life

The Spanish version of the Short Form Healthy Survey (SF-12; 27) was used to evaluate the health-related quality of life (short-form version of the SF-36 Healthy Survey; 28). This instrument validated for the Spanish population consists of 12 items derived from the eight sections of the SF-36: 1 - general health (item 1), 2 - physical function (items 2a and 2b), 3 - physical role functioning (item 3a and 3b), 4 - emotional role functioning (items 4a and 4b), 5 - bodily pain (item 5), 6 - social role functioning (item 7), 7 - mental health (items 6a and 6c) and 8 - vitality (items 6b; 29). Two component summaries result from these eight sections: the physical component summary (PCS) and the mental component summary (MCS). In each of the eight sections, the items are coded on a scale from 0 (worst health state) to 100 (best health state), with risk

Table 1
Characteristics of the study participants

	Total (n=351)		Women (n=201)		Men (n=150)		
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**p value**
Age (years)	71.06		71.76	8.49	70.13	8.56	0.08
Mean							
Marital status (%)							0.05
Single	9 (2.6)		6 (3.0)		3 (2.0)		
Married	220 (62.7)		114 (56.7)		106 (70.7)		
Widowed	96 (27.4)		67 (33)		29 (19.3)		
Cohabiting	14 (4.0)		7 (3.5)		7 (4.7)		
Divorced	12 (3.4)		7 (3.5)		5 (3.3)		
Years of education							
Mean	8.73	5.59	8.31	5.66	9.28	5.48	0.11
Place of residence (%)							0.55
Rural	72 (20.5)		39 (19.4)		33 (22)		
Urban	279 (79.5)		162 (80.6)		117 (78)		
Alcohol consumption (%)							0.00
No	152 (43.3)		108 (53.7)		44 (29.3)		
Yes. sporadic	164 (46.7)		85 (42.3)		79 (52.7)		
Yes. regular	35 (10.0)		8 (4)		27 (18.0)		
Tobacco smoking (%)							0.03
No	272 (77.5)		167 (83.1)		105 (70.0)		
Yes. sporadic	17 (4.8)		6 (3.0)		11 (7.3)		
Yes. regular	62 (17.7)		28 (13.9)		34 (22.7)		
BMI (kg/m2)							
Mean	27.56	4.92	27.59	4.66	27.52	5.32	0.90
MD Adherence							
Mean	4.93	1.58	5.06	1.53	4.75	1.63	0.09

MD: Mediterranean diet. BMI: Body mass index

scores equal to or lower than 30 (30). Research studies using the SF-12 have shown that this instrument is a reliable and valid measure, with internal consistency estimates higher than 0.70 and significant correlations between the versions (31,32).

Sociodemographic, clinical and lifestyle data

A questionnaire prepared "ad hoc" was used to collect sociodemographic, clinical and lifestyle data. The following sociodemographic data were collected in our study: age, sex, marital status, years of education and place of residence. The following clinical variables were studied: blood glucose levels, blood cholesterol levels, systolic blood pressure and diastolic blood pressure, weight and height. Lastly, the following lifestyle variables (reported by the participants), were studied: alcohol consumption, tobacco smoking and physical activity (hours/week).

Anthropometric data

Standardised methods were used to measure anthropometric data. Body weight was measured using a SECA 700 mechanical column scale with sliding weights, with 100-g accuracy. Height was measured with a precision of 0.2 cm using a vertical stadiometer. The body mass index (BMI=weight/height2, kg/m2) was calculated using the weight and height data in kg and m, respectively. BMI was interpreted using the World Health Organization classification ("BMI<18.5 low weight", "BMI ranging from 18.5 to 24.99 normal weight", "BMI ranging from 25 to 29.9 overweight" and "BMI>30 obesity").

Procedure

Measurements of the variables were performed by trained personnel with experience in nutritional assessment and questionnaire administration. All questionnaires were entered

Table 2
Lifestyle, anthropometric and sociodemographic variables according to the level of adherence to the Mediterranean diet in men and women

	Men				Women			
MDS	**Low**	**Medium**	**High**	**p value**	**Low**	**Medium**	**High**	**p value**
	<4	**4-6**	**>6**		**<4**	**4-6**	**>6**	
Age (years)								
Mean	68,37	70,70	70.84	0.041	71.69	72.36	71.03	0.593
95% CI	65.6-71.2	70.36-73.12	69.43-72.25		68.2-75-2	70.6-74.1	69.2-72.8	
Physical activity (h/week)								
Mean	2.94	5.53	6.10	0.011	2.84	3.46	4.22	0.041
95% CI	1.6-4.2	4.0-7.1	4.4-7.8		1.26-4.4	2.3-4.7	2.8-5.7	
Glucose levels								
Mean	114.90	107.60	101.95	0.049	94.67	97.88	102.37	0.253
95% CI	90.6-139.2	99.1-116.2	96.1-107.8		89.8-99.5	92.5-103.3	96.9-107.8	
Cholesterol levels								
Mean	197.32	198.35	189.63	0.036	195.78	199.54	197.97	0.842
95% CI	179.9-214.7	190.4-206.3	177.6-201.7		187.0-204.5	193.8-205.3	189.3-206.6	
Systolic blood pressure								
Mean	132.76	127.18	130.44	0.231	123.26	127.45	126.43	0.381
95% CI	126.1-139.4	123.3-131.1	126.7-134.2		117.6-128.9	124.3-130.6	123.3-129.5	
Diastolic blood pressure								
Mean	78.79	78.45	77.42	0.834	75.84	73.28	72.71	0.412
95% CI	73.7-83.9	75.3-81.6	75.1-79.8		71.3-80.3	71.1-75.5	70.2-75.3	
BMI								
Mean	26.57	27.20	28.50	0.223	27.07	27.82	27.51	0.734
95% CI	24.7-28.5	25.8-28.6	27.1-29.9		25.5-28.7	26.9-28.8	26.4-28.6	
Years of education								
Mean	10.06	8.73	9.28	0.522	9.23	8.05	8.27	0.610
95% CI	6.9-12.4	6.1-10.8	7.9-12.7		7.9-11.9	6.7-10.3	6.2-10.3	
Place residence (%)								
Urban	30 (26,5)	44 (37,6)	43 (36,8)	0.450	27 (16,7)	4 (10,3)	16 (41.0)	19 (48,7)
Rural	5 (15,2)	15 (45,5)	13 (39,4)			79 (48,8)	56 (34,6)	0.430

95% CI, 95% confidence interval. BMI: Body mass index

into a computer by the interviewers while they conducted the interviews using a booklet prepared "ad hoc". A pilot study was performed using a small sample to assess the summarised items and the questionnaire viability and administration procedure before the beginning of the study.

Analysis

Sample descriptive data are expressed as the mean and standard deviation. Differences between continuous variables were compared using Student's t test. Categorical variables were analysed using the X2 test.

Analysis of variance (ANOVA), adjusted by Bonferroni's multiple comparison for continuous variables and the X2 test for categorical variables, was performed to study the relationship between anthropometric sociodemographic characteristics, lifestyles and the level of adherence to the MD. All results were stratified by sex.

The association between life satisfaction, health-related quality of life and the MD was analysed by multiple logistic regression. The results are expressed as regression coefficients (β), the confidence interval and the p value. The analysis of the total regression model included potential confounding factors as covariates, with adjustments for age, BMI, hours of physical activity, blood cholesterol levels, blood glucose levels and

blood pressure levels. Regression coefficients, the p value and the 95% confidence intervals stratified by sex were estimated.

The analyses were performed using the Statistical Package for the Social Sciences (SPSS) software version 22.0 with a significance level of $p<0.05$ in all cases.

Results

Table 1 shows the distribution of the 351 participants according to sociodemographic, anthropometric and lifestyle variables. The mean age was 71.06 years; 57.23% (201) of the participants were women, and 42.77% (150) were men. Comparisons between study population characteristics showed no significant differences as a function of age (p=0.08), education level (p=0.11), marital status (p=0.05), place of residence (0.55) and BMI (p=0.90). The prevalence of adherence to the MD was lower among men than among women. Furthermore, men had significantly ($p<0.05$) higher consumption of alcohol and smoking tobacco than women (Table 1).

Table 3
Regression coefficients for the relationship between the Mediterranean Diet Score (MDS) and Life Satisfaction scale in men and women

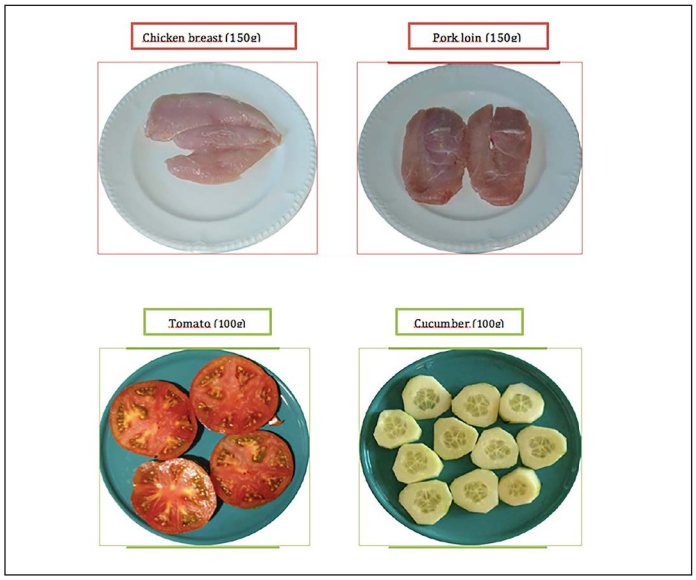
	Life Satisfaction		
	β	95% CI	p value
Women			
MDS (1 unit)			
Model 1*	0.17	0.02-0.31	0.012
Model 2 τ	0.22	0.62-0.37	0.005
Men			
MDS (1 unit)			
Model 1*	0.02	-0.13-0.19	0.800
Model 2 τ	-0.10	-0.28-0.07	0.310

* Model 1: Adjusted for age; τ Model 2: Adjusted for age, hours of physical activity, educational level, body mass index, blood cholesterol, blood glucose levels and blood pressure levels

Participants with better adherence to the MD (>6) were more physically active (p=0.010) and had better health-related quality of life ($p<0.05$) and lower consumption of alcoholic beverages (p=0.040). The ratio of smokers decreased in both sexes according to the tertile of distribution. Women also had a higher degree of life satisfaction (p=0.031). Significant differences between the degree of adherence to the MD and cholesterol levels, glucose levels and age were observed for men. Specifically, elderly men (p=0.041) showed greater adherence to the MD, better glucose levels (p=0.049) and better blood cholesterol levels (p=0.036; Table 2). A slight association was observed between the degree of adherence to the MD and the educational level; specifically, low levels of adherence to the MD were found among subjects with high educational level, with non-significant differences.

Multiple linear regression models were constructed and adjusted to analyse the association between the MD and life satisfaction and physical and mental function among men and women. The fully adjusted model of life satisfaction (table 3) showed a direct relationship with adherence to the MD among women ($p<0.05$), although the connection was non-significant in the case of men (p=0.31). The age-adjusted model (table 4) shows a significant and direct association between adherence to the MD and mental function for both sexes and physical function only for men. The fully adjusted model showed a decreased association between physical function and MD in the case of men (p=0.06) and an increased association in the case of women (p=0.02). Conversely, the association between the mental section and adherence to the MD remained statistically significant.

Figure 1
Example of the photo album



Discussion

The results from this study show the relationship between the degree of adherence to the MD, health-related quality of life and life satisfaction among older adults. The mental and physical domains of the health-related quality of life were directly associated with the adherence to the MD among men and women. Furthermore, a direct relationship between the MD and life satisfaction was found among women. Adherence to the MD was inversely correlated with alcohol consumption and tobacco smoking and directly related to active lifestyles in the present study.

The results of health-related quality of life corroborate

Table 4
Regression coefficients for the relationship between the Mediterranean Diet Score (MDS) with mental component score (MCS) and physical component socre (PCS) of SF12 in men and women

	MCS (SF12)			FCS (SF12)		
	β	**95% CI**	**p value**	**β**	**95% CI**	**p value**
Women						
MDS (1 unit)						
Model 1*	0.03	-0.12-0.18	0.007	0.09	-0.05-023.	0.160
Model 2 τ	0.07	-0.96-0.23	<0.001	0.19	0.04-0.34	0.020
Men						
MDS (1 unit)						
Model 1*	0.00	-0.16-0.15	0.002	0.13	-0.05-0.30	0.010
Model 2 τ	0.01	-0.12-0.29	0.004	0.05	-0.17-0.20	0.060

* Model 1: Adjusted for age; τ Model 2: Adjusted for age, hours of physical activity, educational level, body mass index, blood cholesterol, blood glucose levels and blood pressure levels

the findings of cohort studies conducted in Spain among the adult population, wherein adherence to the MD was directly and positively associated with the self-perceived mental and physical sections (1, 33). Similar results were also found in studies on the adherence to the MD and its antioxidant function that were conducted internationally among the older adult population; the studies concluded that the MD pattern was associated with good health-related quality of life and specifically with good mental and physical health (17, 34).

Few national studies on life satisfaction and its relationship with food have been published. Such studies were performed in children and young people to analyse the relationship between the MD and life satisfaction. The results of those studies showed that adolescents with a higher degree of adherence to the MD were more satisfied with their lives and had a more active lifestyle. Such results are highly coincident with the findings of our study (19,20). International studies analysing this relationship are scarce. There are some studies that analyse the relationship of vital satisfaction with sociodemographic factors and conclude that there are differences according to sex (35-37). These findings are consistent with our conclusion. On the other hand, some studies performed in obese population with the objective of identifying the relationship between obesity and life satisfaction has been published. Its results show that the obesity is negatively associated with life satisfaction, (17, 38). Also studies analysing the relationship between life satisfaction and the risk for neurodegenerative diseases with key clinical implications have been published, although nutritional variables were neglected (39-41). However, no study analysing life satisfaction regarding to the adherence to the MD in the older adult population has been published.

Many studies focusing on diet quality and its relation with health determinants, including metabolic syndrome, cardiovascular diseases or nutritional status, have been published in the scientific literature (42-49). However, there are few scientific reports on the older adult population with a focus on the relationship between eating habits and measures of health-related quality of life that are capable of quantifying different health stages and their determinants, despite the complexity of health determinants and age-related needs (17).

The present study has several limitations. Firstly, causality cannot be deduced from a cross-sectional descriptive study. On the other hand, the instruments used to quantify food intake, such as food frequency questionnaires, measure food consumption in the last year and are vulnerable to systematic measurement errors, although the use of validated questionnaires decreases this possible limitation. Furthermore, a photographic food atlas with the size of portions was also used to facilitate the completion of the questionnaires and minimise memory bias. Related to the sample selection, participants were recruited following a snowbal strategy, which could have reduced the variability of the sample. Thus, the findings might not be generalizable. Lastly, the clinical and health data were self-perceived, which may underestimate the results. However, self-perceived data are likely the most reliable and predictive health measurement and have shown satisfactory validity and reliability in comparisons of measurements by expert professionals in population studies and in a specific context (50-55).

This study has a direct clinical implication. Our results show that adherence to the MD is positively related with both variables to health-related quality of life and life satisfaction. Therefore, the inclusion of measure, intervention and following of the MD adherence could improve the level of health-related quality of life and life satisfaction of our patients, in all clinical levels.

In conclusion, the adherence to the MD is directly associated with the self-perceived physical and mental function of the health-related quality of life for both sexes and with life satisfaction for women. This is the first study performed

among the older adult population that evaluates the relationship between adherence to the MD and health-related quality of life and analyses life satisfaction, which is considered a key measurement of subjective well-being and may positively or negatively affect health (39). Further studies that include well-being indicators must be performed in older adult populations to obtain conclusive results on the MD effect on health-related quality of life. Such studies should serve as a basis to establish new dietary recommendations adapted to the needs of this age group.

Disclosure statements: We hereby declare that this manuscript has not been previously published anywhere else and that it is not currently being evaluated by any other scientific journal. All the authors have been involved in designing and conducting the study, and they have approved the final version of the manuscript. Furthermore, this paper does not present any economic, institutional, organisational, or authorial conflicts of interest. We grant the Public Heatlh Nutrition the exclusive rights to edit, publish, reproduce, distribute copies, prepare related paper, electronic or multimedia documents, and to include the article in national and international indexes or databases.

Conflict of Interest: The authors do not have any conflicts of interest.

Ethical standard: All experimental procedures were conducted in accordance with the guidelines in the Declaration of Helsinki and approved by the Bioethics Committee of University of Alicante in Spain.

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